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Non-Fungible Tokens (NFTs)

Non-fungible tokens (NFTs) have become popular as unique and non-interchangeable units of data that signify ownership of associated digital items, such as images, music, or videos. Token “ownership” is recorded and tracked on a blockchain (a digital database that records data on a decentralized network of computers without the use of a central authority). In the future, supporters believe NFTs will be used as digital representations of physical items, such as a deed to a house or title to a car. NFTs are commonly used to record and represent ownership of an item, verify authenticity, and enable exchange. However, they do not necessarily reflect the legal ownership of an asset or grant copyright to a digital or physical item. NFT owners purchase only the right to the NFT’s blockchain metadata or “token,” not the underlying asset, unless otherwise specified in external contracts or terms and conditions.

NFTs share many similarities with cryptocurrencies, and they are commonly bought and traded using cryptocurrency. Both NFTs and cryptocurrencies are built and tracked on blockchains, and they share much of the same customer and community base. However, cryptocurrencies are fungible, meaning interchangeable, whereas NFTs are unique and therefore non-fungible. Most users create and buy NFTs on dedicated NFT marketplaces. For a typical NFT, it is created or “minted” on a blockchain, auctioned off or sold at a fixed price on an NFT marketplace, and “stored” in the buyer’s digital wallet. Smart contracts (self-executing contracts or lines of computer code on a blockchain) can mint NFTs or transfer them from one owner to another. In combination, blockchains and smart contracts are the backbone of the NFT ecosystem.

Estimates for the size of the NFT market range from around \$17 billion to over \$44 billion in annual sales. According to some market analytic companies, sales increased substantially in 2021 but have decreased in 2022. Some high-profile NFTs have sold for millions of dollars, while one study found that 1% of NFTs sell for over \$1,594 and that roughly three-quarters of NFTs are sold for less than \$15. The NFT market is similarly stratified and concentrated. The two largest marketplaces, OpenSea and LooksRare, account for nearly all monthly NFT trading volume. Additionally, one study found that the top 10% of NFT buyers and sellers make as many transactions as the remaining 90%. The latter statistic may reflect the prevalence of illicit trading practices.

As of 2022, most NFTs are used to purchase digital collectibles, such as digital artwork, or representations of other digital items. However, proponents believe NFTs will find wider application in other fields, such as representing real-world items; enabling digital identities; or granting exclusive access to events, services, or online communities. NFTs may become popular in these fields or may remain specific to certain markets. If NFTs in their current form become obsolete, the technology and core concepts of decentralization, unique digital ownership, and immutability may take different forms or develop into other new technologies.

Despite substantial market growth over the past two years, NFTs are still relatively nascent. In their current form, NFTs have implications in a variety of policy areas:

- **Consumer protection.** There are a number of risks to consumers in the NFT ecosystem, and some NFT marketplaces and digital wallets lack basic features to protect consumers from fraud and misleading or deceptive practices.
- **Financial regulation.** Depending on the purpose and use of NFTs, some NFTs and NFT platforms may fall under existing financial regulatory regimes and definitions.
- **Copyright and intellectual property.** The relationship between NFTs and the legal ownership of digital or physical property is unclear. Some existing regulations may impact NFT markets.
- **Energy and environmental.** Both minting and selling NFTs require substantial amounts of energy, which has raised concerns about their environmental impact.

Depending on how NFTs develop in the future, Congress may also consider possible privacy or content moderation concerns. If Congress determines that there is a role for the federal government in regulating NFTs, it may consider a variety of options to extend oversight over NFTs while fostering innovation. Since NFTs are used in a range of industries and applications, Congress may consider whether to treat NFTs as a class of technology or address specific NFT applications in certain sectors. Congress may also consider the distinctions between different types of NFTs and their respective purposes in the context of broader decentralized ecosystems and markets, such as cryptocurrencies and decentralized finance.

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Introduction

Non-fungible tokens (NFTs) are unique and non-interchangeable units of data that can signify ownership of associated digital items, such as images, music, or videos. Supporters believe NFTs will be used in the future to represent ownership of physical items (e.g., a deed to a car or title to a house). Token “ownership” is recorded and tracked on a blockchain, a digital database that records data on a decentralized network of computers.¹ NFTs can themselves be sold or traded in digital markets. However, ownership of an NFT does not necessarily correspond to legal ownership or grant copyright to a digital or physical item. NFT owners purchase only the right to the NFT’s blockchain metadata or “token,” not the underlying item, unless otherwise specified.

In 2014, the first NFT was created as part of an annual collaboration event for artists and technologists.² Currently, NFTs are created or “minted” on a blockchain, auctioned off, or sold at a fixed price in NFT marketplaces (online exchanges for NFTs) and “stored” in a buyer’s digital wallet.³ NFTs began as a way for artists to control, sell, and earn royalties on digital artworks, but they gained more mainstream popularity after the growth of NFT-based games and marketplaces in 2017.⁴ Their use has become ubiquitous within digital collectible and art markets, with the total NFT market estimated to be between \$17 billion and \$40 billion in transactions in 2021.⁵

Some proponents assert that NFTs make transactions more efficient and secure. They predict that their use will expand to a wide array of applications beyond the digital collectibles markets, such as digital identity authentication, retail shopping, and real estate. Critics argue that NFTs are simply speculative investments, provide no additional value over existing systems, are prone to illicit activity and scams, and contribute to the “financialization of everything.”⁶

If Congress determines that regulating NFTs is necessary, it may consider whether to treat NFTs as a broad technology class or address specific NFT applications in selected sectors. Congress may also wish to consider how to balance the development of NFT applications with any appropriate consumer, intellectual property, financial, and environmental protections.

This report provides an overview of NFTs and their technical infrastructure, including the use of blockchains and smart contracts (i.e., self-executing contracts on the blockchain).⁷ It also surveys

¹ For more information on blockchain technologies, see CRS Report R47064, *Blockchain: Novel Provenance Applications*, by Kristen E. Busch; and CRS Report R45116, *Blockchain: Background and Policy Issues*, by Chris Jaikaran.

² In 2014, Anil Dash and Kevin McCoy created one of the first NFT projects entitled “monetized graphics.” Anil Dash, “NFTs Weren’t Supposed to End Like This,” *The Atlantic*, April 2, 2021, <https://www.theatlantic.com/ideas/archive/2021/04/nfts-werent-supposed-end-like/618488/>.

³ CRS In Focus IF12079, *Digital Wallets and Selected Policy Issues*, by Paul Tierno and Andrew P. Scott.

⁴ CryptoKitties, created in 2017, is considered one of the first popular mainstream NFT collections. CryptoKitties is a video game developed on the Ethereum blockchain in which users can collect, breed, and trade digital cat NFTs.

⁵ Estimates of the exact size of the NFT market vary. NonFungible.com and L’Atelier BNP Paribas, “The 2021 NFT Market Report: Presented by NonFungible and L’Atelier BNP Paribas,” March 9, 2022, <https://atelier.net/news/the-2021-nft-market-report-presented-by-nonfungible>; Allyson Versprille, “NFT Market Surpassed \$40 Billion in 2021, New Estimate Shows,” *Bloomberg*, January 6, 2022, <https://www.bloomberg.com/news/articles/2022-01-06/nft-market-surpassed-40-billion-in-2021-new-estimate-shows>.

⁶ Some critics believe NFTs and cryptocurrencies contribute to the “financialization of everything,” in which individuals would need to exchange tokens for most interactions and transactions.

⁷ For more information on smart contracts, see “Smart Contracts” section in this report.

various NFT applications and major NFT marketplaces. The report concludes with a discussion of select NFT-related issues of potential congressional interest.

NFTs Overview

What Are NFTs?

NFTs are often compared to digital certificates of ownership.⁸ The certificate, in the form of data recorded on a blockchain, signifies ownership of an associated digital item not contained in the data itself. A blockchain is a digital database that records data on a decentralized network of computers without the use of a central authority.⁹

There are two parts to an NFT (see **Figure 1** and **Table 1** for an example):

- **NFT item.** The digital item associated with an NFT is described in an NFT's metadata (see next bullet). These items are typically stored off-chain, meaning the item is not directly stored on a blockchain.¹⁰
- **NFT metadata (called a token).** NFT metadata¹¹ is stored on a blockchain and typically includes information identifying the underlying NFT item, its location online, its ownership, and transaction information.

Most users create and buy NFTs on dedicated NFT marketplaces. Users can also write their own code to directly mint their NFTs to a blockchain. In either case, the user uploads a digital file of the item, and through the use of smart contracts, the NFT is “minted” or recorded on a blockchain. NFT metadata stored on a blockchain is an example of a token—a unit of data recorded on a blockchain that carries value.¹² A “fungible” token is one that is identical and interchangeable with another. For example, cryptocurrencies are fungible tokens since the units are interchangeable (one Bitcoin for another Bitcoin; one Ether for another Ether). NFTs are “non-fungible,” or non-interchangeable, since each token typically has unique attributes (e.g., an NFT token of one video file is not interchangeable for an NFT token of a different video file). However, multiple NFTs could represent the same digital or physical item (e.g., an artist might sell 40 NFTs of the same image), although each NFT's metadata would be unique.

⁸ U.S. Government Accountability Office, *Science & Tech Spotlight: Non-Fungible Tokens (NFTs)*, GAO-22-105990, June 14, 2022, <https://www.gao.gov/products/gao-22-105990>.

⁹ For more information on blockchain technologies, see CRS Report R47064, *Blockchain: Novel Provenance Applications*, by Kristen E. Busch; and CRS Report R45116, *Blockchain: Background and Policy Issues*, by Chris Jaikaran.

¹⁰ Blockchains have limited storage space and high network traffic, so storing an NFT's underlying digital asset on a blockchain might be expensive and inefficient. Instead, digital assets are typically stored on a separate hosted website or a decentralized peer-to-peer file storage system.

¹¹ Metadata is additional information and data that can describe, contextualize, arrange, track, or enhance other data. Murtha Baca et al., *Introduction to Metadata*, 3rd ed. (Los Angeles: Getty Research Institute, 2016).

¹² An NFT's value is determined by the willingness of people to pay for it. The token is inherently valueless (it is simply data recorded on a blockchain), so the value of any particular NFT may vary widely over time.

Figure I. Example NFT Item

“EVERYDAYS: THE FIRST 5000 DAYS,” created by Beeple



Source: Christie's, <https://onlineonly.christies.com/s/first-open-beeple/beeple-b-1981-1/112924>.

Notes: The above jpeg, created by the digital artist Mike Winkelmann (known as Beeple) sold as a non-fungible token for over \$69 million. Christie's auction house facilitated the sale.

Table I. Example NFT Metadata Recorded on Blockchain

Metadata recorded on-chain in the token for Beeple's NFT

Category	Description
Transaction Hash	A long string of numbers and letters produced from a hashing function (see notes) that uniquely identifies a specific transaction.
Timestamp	The date and time a transaction was validated and added to the blockchain.
“From” Public Key Address	Digital wallet address of the sender, which is a long string of numbers and letters.
“To” Public Key Address	Digital wallet address of the receiver, which is a long string of numbers and letters. When a transaction first executes a smart contract, the location of the smart contract code will be the “to” address.
Transaction Fee	The fee for the blockchain network to verify, validate, and add the transaction to the blockchain.
tokenId	A unique identifier for a specific token on the network.
URL link	If the asset is stored off-chain, the link will point to the asset's location. The link itself is not directly included in the metadata. There is typically a function that inputs the tokenId and outputs the link to the off-chain metadata.
Block Number	The number of the block that contains the transaction.
Nonce	The random number generated to create the unique transaction hash.

Source: Etherscan, which pulls metadata from the Ethereum blockchain and displays it in a database, <https://etherscan.io/tx/0x84760768c527794ede901f97973385bfc1bf2e297f7ed16f523f75412ae772b3>.

Notes: In this context, a uniform resource locator (URL) provides a web address for the location of the NFT asset. A hashing function produces a string of characters as an output given some data as input. This is a one-way function, meaning a hash value may be created from an input, but the input cannot be recreated from the hash.

What Does It Mean to Own an NFT?

“Owning” a non-fungible token refers to being identified as the owner of the NFT in the blockchain metadata and having the right to transfer the token to someone else. The token is often used to signify ownership of an associated digital or physical item, enabled by immutable ownership records on a blockchain. However, the ownership metadata recorded in an NFT does not necessarily represent the legal ownership or grant legal copyright to an associated digital or physical item.¹³ Legal ownership rights conveyed by an NFT may be specified via a reference in the metadata to external terms and conditions or contracts.¹⁴ Despite these legal limitations, participants often purchase NFTs as a purported means for digital authentication and ownership verification. Since it is particularly difficult to prove or transfer the ownership of unique digital items, supporters believe NFTs are a new means for enforcing digital scarcity. Copyright and other intellectual property issues for NFTs are further discussed in the “Congressional Issues” section below.

How Do NFTs Use Blockchains and Smart Contracts?

Blockchains

NFTs are “minted” (i.e., created) on blockchain networks. Data stored on a blockchain are continually shared, replicated, and synchronized across the nodes in a network—individual computer systems or specialized hardware that communicate with each other and store and process information.¹⁵ This system enables tamper-resistant recordkeeping without a centralized authority or intermediary. On a blockchain network, a participant uses a public key to encrypt data and a private key to decrypt the data.¹⁶ Participants can also sign transactions with their private key, and other users can verify those signatures with the corresponding public key. There are various kinds of blockchains. Most share some common characteristics, including decentralization (i.e., no centralized authority), immutability (i.e., the blockchain records are unalterable), and pseudonymity (i.e., users’ real-world identities are not directly displayed).

Users typically mint NFTs on public, permissionless blockchains, which allow any node on the blockchain network to read and submit transactions.¹⁷ A smart contract will mint an NFT by executing lines of code that add the NFT data to the blockchain. The NFT metadata, including

¹³ For more information on property rights, ownership, and NFTs, see Juliet Moringiello and Christopher Odinet, “The Property Law of Tokens,” *Florida Law Review* (forthcoming 2022), November 1, 2021, <http://dx.doi.org/10.2139/ssrn.3928901>.

¹⁴ Florian Idelberger and Peter Mezei, “Non-Fungible Tokens,” *Internet Policy Review Journal on Internet Regulation*, vol. 11, no. 2 (April 11, 2022), <https://policyreview.info/pdf/policyreview-2022-2-1660.pdf>.

¹⁵ There are different types of nodes on a blockchain network. Some nodes may store the entirety or only parts of the blockchain records, while others publish new blocks or simply pass their transactions to other nodes. For more information, see CRS Report R47064, *Blockchain: Novel Provenance Applications*, by Kristen E. Busch.

¹⁶ A user can encrypt his or her identity using a public key to scramble data, as well as a private key, which is necessary to conduct transactions with the public key. Each key is generated through a cryptographic algorithm. “Public key encryption, or public key cryptography, is a method of encrypting data with two different keys and making one of the keys, the public key, available for anyone to use. The other key is known as the private key. Data encrypted with the public key can only be decrypted with the private key, and data encrypted with the private key can only be decrypted with the public key.” Cloudflare, “How Does Public Key Encryption Work? Public Key Cryptography and SSL,” <https://www.cloudflare.com/learning/ssl/how-does-public-key-encryption-work/>.

¹⁷ For more information on the different types of blockchain, such as public, private, permissioned, and permissionless blockchains, see CRS Report R47064, *Blockchain: Novel Provenance Applications*, by Kristen E. Busch.

ownership information, are therefore accessible to all nodes or anyone using a searchable blockchain explorer.¹⁸ Some NFTs are immediately minted on the blockchain after the content creator uploads the file to the marketplace, while others are not recorded on the blockchain until after sale on a marketplace.

Most NFTs are minted on the Ethereum blockchain. Some NFTs are minted on other blockchains, such as Solana, Flow, or Cardano. Most NFTs are purchased with Ether (ETH, the cryptocurrency native to the Ethereum network) or another cryptocurrency. Price changes in cryptocurrencies often result in changes in NFT valuations.

Smart Contracts

Smart contracts are self-executing contracts that enable the exchange of money, property, or something else of value without the services of a third party.¹⁹ They are commonly used to mint NFTs, transfer their ownership, or pay royalties. More specifically, a smart contract is a computer program, or a set of lines of code, that resides at a specific address on a blockchain.²⁰ Smart contracts are automatically executed by the computers in the blockchain network if a specific set of conditions are met or the smart contract is “called.” Once the conditions are met (e.g., the smart contract receives a transaction), the smart contract code will run as programmed to either mint an NFT, transfer the NFT, pay royalties, or execute some other predetermined transaction.²¹ All smart contracts rely on external transactions to trigger their functions.²²

Most users mint their NFTs via a marketplace, which manages the smart contract and back-end coding to mint on a blockchain.²³ Marketplaces are discussed in the section “NFT Marketplaces.” A user can also write his or her own code to create a smart contract on a blockchain and mint tokens using the smart contract. To create an NFT, a smart contract must include certain code and programming commands that follow accepted industry standards, such as ERC-721 or ERC-1155 for Ethereum NFTs. These standards allow wallets, marketplaces, and other platforms to work with any token that conforms to the standard.²⁴ NFTs built on other blockchains may use different standards or protocols.

Smart contract code is visible to all blockchain participants, which enables hackers or bad actors to search for bugs and security vulnerabilities to exploit. According to Ethereum’s own

¹⁸ Blockchain explorers pull data from a blockchain, such as Ethereum or Bitcoin, and display it in a searchable database, which can be accessed by anyone with a web browser. Etherscan is a popular blockchain explorer for Ethereum cryptocurrency and NFT transactions. Other examples include Polygonscan for Polygon transactions and Explorer for Solana transactions.

¹⁹ The term *smart contract* was coined in the mid-1990s by cryptographer Nick Szabo. See Nick Szabo, “Smart Contracts: Building Blocks for Digital Markets,” *Extropy* #16, 1996, https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_2.html.

²⁰ Since the majority of NFTs and smart contracts are built on Ethereum, see Ethereum, “Introduction to Smart Contracts,” <https://ethereum.org/en/developers/docs/smart-contracts/>.

²¹ Nick Szabo analogized smart contracts as digital vending machines. Given the right input (coins), they will dispense a certain output (soda cans). However, unlike vending machines, smart contracts can automate many kinds of exchange or certain commands.

²² For example, code in the smart contract may create a certain number of tokens and assign them to a particular owner or transfer ownership between addresses. For example code, see “Anatomy of Smart Contracts,” Ethereum, <https://ethereum.org/en/developers/docs/smart-contracts/anatomy/>.

²³ Mitchell Clark, “How to Create an NFT—and Why You May Not Want To,” *The Verge*, December 8, 2021, <https://www.theverge.com/22809090/nft-create-opensea-rarible-cryptocurrency-ethereum-collectibles-how-to>.

²⁴ Ethereum, “How to Mint an NFT (Part 2/3 of NFT Tutorial Series),” <https://ethereum.org/en/developers/tutorials/how-to-mint-an-nft/>.

developers page, “smart contract code usually cannot be changed to patch security flaws, assets that have been stolen from smart contracts are irrecoverable, and stolen assets are extremely difficult to track. The total of amount of value stolen or lost due to smart contract issues is easily over \$1B.”²⁵ The real figure of stolen funds due to vulnerabilities in smart contracts may be much higher.²⁶

Off-Chain Storage

In most cases, the underlying NFT item, such as a jpeg image or mp3 audio file, is stored off-chain, as blockchains have limited storage space and high network traffic. Storing an NFT’s underlying item directly on a blockchain would typically be expensive and inefficient. Instead, items are typically stored separately on an external hosting service, such as a centralized server (e.g., a server hosted by OpenSea), a distributed file system (e.g., the Interplanetary File System or Arweave), or cloud storage (e.g., Amazon Web Services).

One common misconception is that NFTs are impervious to security risks as data are recorded on immutable blockchains. However, the blockchain secures only NFT metadata, not the underlying asset. NFT metadata stored directly on the blockchain are immutable²⁷ (i.e., tamper-proof), but data stored off-chain can be manipulated. If off-chain storage systems go offline or are discontinued, the NFT asset and any off-chain metadata may disappear. This is called “link rot,” because following a broken link on a blockchain will return only an error message stating that the file at the provided address cannot be found (a “404” error).²⁸ In this situation, the on-chain metadata may continue to signify ownership of the NFT, but the NFT asset itself may no longer be available. Typically, this results in the NFT losing value.

How Are NFTs Stored?

Digital Wallets

A digital wallet is software or hardware designed to store a user’s cryptographic public and private keys, which may correspond to NFTs, cryptocurrencies, or other identifiers and credentials. Digital wallets can take various forms. Web-based wallets are often installed as browser extensions or mobile applications. Hardware wallets allow users to store their public and private keys offline without a connection to the Internet to prevent hacking.²⁹ Many digital wallets can be hacked,³⁰ and users who lose their private keys may lose access to their funds and tokens.

²⁵ Ethereum, “Smart Contract Security,” last updated March 23, 2022, <https://ethereum.org/en/developers/docs/smart-contracts/security/>.

²⁶ MacKenzie Sigalos, “Crypto Scammers Took a Record \$14 Billion in 2021,” CNBC, January 6, 2022, <https://www.cnbc.com/2022/01/06/crypto-scammers-took-a-record-14-billion-in-2021-chainalysis.html>.

²⁷ Blockchain data are immutable because of the hashing functions used to encrypt data. For more information on hashing functions, see CRS Report R47064, *Blockchain: Novel Provenance Applications*, by Kristen E. Busch; and CRS Report R45116, *Blockchain: Background and Policy Issues*, by Chris Jaikaran.

²⁸ Jacob Kastrenakes, “Your Million-Dollar NFT Can Break Tomorrow If You’re Not Careful,” The Verge, March 25, 2021, <https://www.theverge.com/2021/3/25/22349242/nft-metadata-explained-art-crypto-urls-links-ipfs>.

²⁹ CRS In Focus IF12079, *Digital Wallets and Selected Policy Issues*, by Paul Tierno and Andrew P. Scott.

³⁰ Corin Faife, “Discord Hacking Is the Newest Threat for NFT Buyers,” The Verge, January 7, 2022, <https://www.theverge.com/2022/1/7/22870912/nft-communities-boom-discord-hackers-cryptocurrency-webhooks>; Tomio Geron, “Bored Ape Yacht Club NFT Theft Shows the Ease of Hacking Crypto,” Protocol, January 7, 2022,

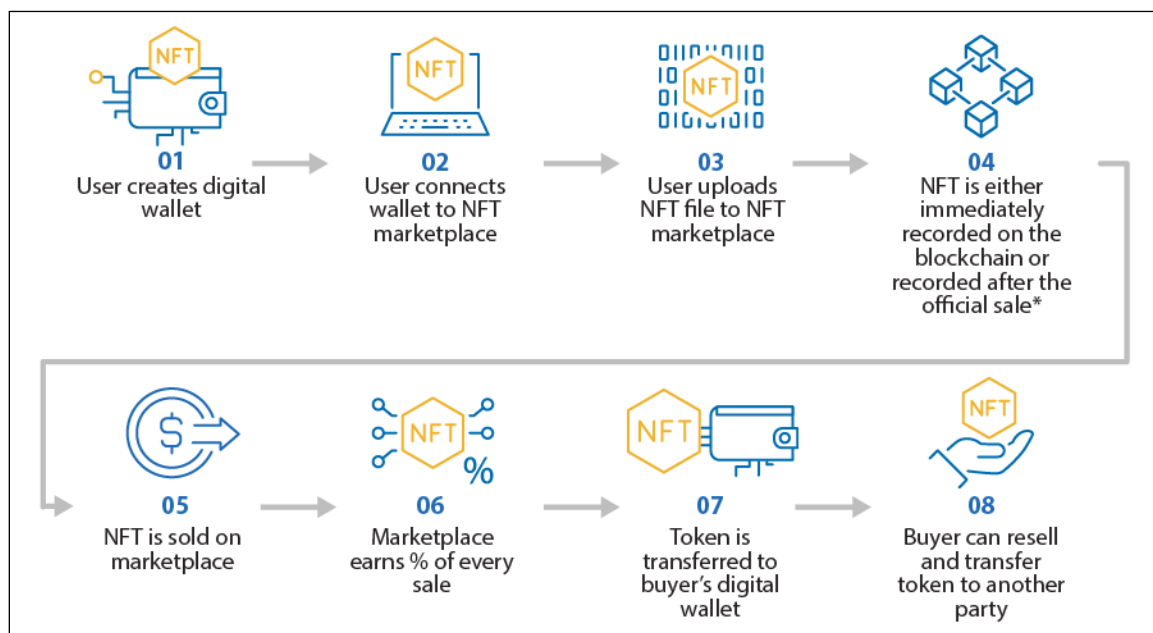
When an individual purchases an NFT, the NFT item, such as the image file featured in **Figure 1**, appears in the user's wallet through an application programming interface (API), which allows software applications to communicate and share data. In other words, the wallet "reads" entries from the blockchain to determine what to display. The NFT item is still stored off-chain but is viewable in the wallet through the API, which enables third-party software to communicate with a blockchain and leverage its data.³¹

NFT Marketplaces

Typically, NFTs are sold on online NFT marketplaces for a fixed price or auctioned amount. An NFT marketplace is a web-based platform for the sale and exchange of NFTs, similar to exchanges dedicated to cryptocurrencies. Some NFT marketplaces accept payments in fiat currency, such as the U.S. dollar, but most strictly accept cryptocurrency. Owners can also sell or trade NFTs without third-party intermediaries. Some NFT marketplace operators pay royalties to creators after each sale, enabling continued income for artists and other content creators as NFTs of their content are transferred and re-sold.

The process of creating a digital wallet, minting an NFT, selling the NFT on an NFT marketplace, and transferring ownership is illustrated in **Figure 2**. There is a transaction fee for every transaction recorded on the blockchain, such as minting, selling, or re-selling an NFT. The transaction fee compensates the network for verifying the transaction.

Figure 2. NFT Transaction Process



Source: CRS.

<https://www.protocol.com/fintech/bored-ape-hack-nft>; Lorenzo Franceschi-Bicchierai, "NFT Collector 'ILovePonzi' Loses Valuable Ape NFTs to Hackers, Is Upset," *Vice*, February 1, 2022, <https://www.vice.com/en/article/5dg5xq/nft-collector-iloveponzi-loses-valuable-ape-nfts-to-hackers-is-upset>.

³¹ Alchemy and Infura are the two most commonly used APIs used to display NFTs in user wallets, among other blockchain-related services.

Notes: * Some marketplaces, such as OpenSea and Rarible, offer “free” NFT minting options. In this case, the NFT is not officially recorded on the blockchain until after its sale, so the buyer, rather than the creator, pays the minting fee. In other methods, the NFT is immediately minted on the blockchain before the official sale.

Estimates for the size of the NFT market range from around \$17 billion to over \$40 billion in annual trading volume.³² These numbers may be inflated by illicit trading practices such as “wash trading,” discussed more below in the “Financial Regulation” section. According to some market analytic companies, the number and value of NFT sales substantially increased in 2021 but have decreased in 2022.³³ Weekly NFT trading volume peaked at \$1.07 billion in August 2021 but fell to \$52 million in mid-May 2022, according to one NFT industry data aggregator.³⁴

Although supporters claim that NFTs have revolutionized digital art marketplaces and online ownership,³⁵ many creators and users either do not earn profits or may lose money buying and selling NFTs. Some NFTs have sold for millions of dollars, but one study found that 1% of NFTs sell for more than \$1,594 and that roughly three-quarters of NFTs sell for less than \$15.³⁶ Another analysis found that a third of NFTs minted since January 2021 ended up in a “dead collection, with little or no trade activity post-minting.”³⁷ According to the same study, one in three NFTs trade at a price above the minting costs and make a profit. These estimates have been corroborated by other industry studies, which observed that one in five NFT minters realize a profit.³⁸

Marketplace Concentration

Activity in the NFT market is highly concentrated among a few marketplace platforms. OpenSea is one of the largest NFT marketplaces, with a market valuation of \$13.3 billion as of January 2022.³⁹ In December 2021, the company processed 84% of the \$2.7 billion spent on peer-to-peer NFT transactions that month.⁴⁰ In 2022, another marketplace called LooksRare grew in market share. By April 2022, LooksRare had rapidly grown to process around \$3 billion in transactions, nearly the same amount as OpenSea.

Buyers and sellers in NFT markets are similarly stratified and concentrated. Within these markets, a minority of NFT artists and collectors hold the majority of wealth created from NFT art.⁴¹ One

³² Estimates of the exact size of the NFT market vary. NonFungible.com and L’Atelier BNP Paribas, “Yearly NFT Market Report 2021,” Versprille, “NFT Market Surpassed \$40 Billion in 2021.”

³³ Nonfungible.com, Market Tracker.

³⁴ CryptoSlam, “Weekly Trading Volume,” <https://www.theblockcrypto.com/data/nft-non-fungible-tokens/nft-overview>.

³⁵ Andrew R. Chow, “NFTs Are Shaking Up the Art World—but They Could Change So Much More,” *Time*, March 22, 2021, <https://time.com/5947720/nft-art/>.

³⁶ Matthieu Nadini et al., “Mapping the NFT Revolution: Market Trends, Trade Networks, and Visual Features,” *Nature Scientific Reports*, October 22, 2021.

³⁷ Nansen, “NFT Minting Behavior: What Does the Data Teach Us About the Market?,” March 25, 2022, <https://www.nansen.ai/research/nft-minting-behavior-data>. Nansen surveyed roughly 8,400 collections composed of more than 19 million NFTs on the Ethereum blockchain.

³⁸ Chainalysis, “The 2021 NFT Market Report,” January 2022, <https://go.chainalysis.com/rs/503-FAP-074/images/Chainalysis%20NFT%20Market%20Report.pdf>.

³⁹ *New York Times*, “OpenSea Valued at \$13.3 Billion in New Round of Venture Funding,” January 4, 2022, <https://www.nytimes.com/2022/01/04/business/opensea-13-billion-valuation-venture-funding.html>.

⁴⁰ CryptoSlam and CryptoArt via The Block, “NFT Marketplace Monthly Volume,” <https://www.theblock.co/data/nft-non-fungible-tokens/marketplaces>.

⁴¹ Clive Thompson, “The Untold Story of the NFT Boom,” *New York Times Magazine*, August 12, 2021,

study found that the top 10% of NFT buyers and sellers make as many transactions as the remaining 90%.⁴² The process of NFT whitelisting, in which a list of pre-approved traders or followers may purchase new NFTs at discounted prices, may contribute to high concentration in the NFT marketplace.⁴³

Transaction Fees

Every transaction on a blockchain network requires a transaction fee (called a gas fee on the Ethereum network). Individuals can pay higher transaction fees to have their transactions processed more quickly. For example, Ethereum transactions can take anywhere from five minutes on average to multiple hours to be confirmed. Paying a higher transaction fee may cut that time down to 30 seconds or less. If many users pay to complete their transactions faster, the resulting “gas war” drives up transaction fees for all participants. Gas wars are common for limited edition NFTs because buyers who lose the gas war may not be able to purchase the NFTs. More complex transactions are also typically more expensive. NFT-related transactions, such as minting and transferring, require smart contracts and therefore may be more expensive than simple cryptocurrency transfers. For example, deploying a smart contract (i.e., creating the smart contract code on the blockchain) needs much more gas than a simple cryptocurrency transfer.⁴⁴

Transaction fees are variable but substantially impact the profitability of creating, buying, and selling NFTs. Transaction fees may fluctuate based on a variety of factors, including time of day and network traffic. For example, average daily transaction fees on Ethereum range from two dollars to over \$200 depending on the day.⁴⁵ High fees may deter some users from trading low-value NFTs. About a third of all NFTs minted since January 2021 have had little to no trading since being minted, and another third traded below the initial cost of minting (i.e., below the initial transaction fee to create the NFT).⁴⁶

Marketplace Policies

Most NFT marketplaces claim to delist NFTs that abuse or violate the platform’s terms and conditions (meaning an NFT is removed from the marketplace but remains on the blockchain). Some of these terms and conditions have changed over time. For example, OpenSea initially had an approval process to prevent online abuse but later removed that requirement.⁴⁷ In January 2022, the company limited users to creating 50 NFTs in order to prevent scammers from mass producing plagiarized, fake, or spam NFTs,⁴⁸ but within 24 hours, OpenSea reversed its decision after pushback from NFT creators.⁴⁹ In May 2022, OpenSea introduced an automated system to

<https://www.nytimes.com/2021/05/12/magazine/nft-art-crypto.html>.

⁴² Nadini et al., “Mapping the NFT Revolution.”

⁴³ Joanna Ossinger, “Small Group of Insiders Is Reaping Most of the Gains on NFTs, Study Shows,” *Bloomberg*, December 6, 2021, <https://www.bloomberg.com/news/articles/2021-12-06/small-group-is-reaping-most-of-the-gains-on-nfts-study-shows>.

⁴⁴ “Deploying Smart Contracts,” Ethereum, last updated January 27, 2022, <https://ethereum.org/en/developers/docs/smart-contracts/deploying/>.

⁴⁵ See Etherscan, “Average Transaction Fee Chart,” <https://etherscan.io/chart/avg-txfee-usd>.

⁴⁶ Nansen, “NFT Minting Behavior.”

⁴⁷ Justin Scheck, “OpenSea’s NFT Free-for-All,” *Wall Street Journal*, February 12, 2022, <https://www.wsj.com/articles/openseas-nft-free-for-all-11644642042>.

⁴⁸ Scheck, “OpenSea’s NFT Free-for-All.”

⁴⁹ Shanti Escalante-De Mattei, “After Announcing NFT Limit, OpenSea Reverses Course amid User Uproar,”

identify and remove “copies of authentic NFT content” (i.e., prevent the same asset from being minted and sold multiple times).⁵⁰ Other NFT marketplaces, such as SuperRare and Nifty, require all sellers and collections to be verified. Common verification requirements include providing a seller’s social media handles, contact information, or draft files for artwork. On OpenSea and Rarible, verification is optional but may increase the credibility of an NFT. Some marketplaces display special badges on verified artist profiles or NFT collections. Scammers have previously duped Rarible’s verification process and impersonated famous artists.⁵¹

NFT marketplaces may also lack some of the basic security and oversight features of other online platforms or marketplaces. Many NFT marketplaces do not offer two-factor verification or require personally identifiable information (PII) for account verification. In comparison, some cryptocurrency exchanges—such as Coinbase and Binance—offer two-factor account verification and require PII to create an account. These exchanges require users to provide information such as a name, residential address, Social Security number, and supporting documents to gain access to these exchanges and participate in trading.

How Else Are NFTs Used?

As of 2022, most NFTs are used to represent ownership and facilitate the purchase and transfer of digital collectibles, such as digital artwork. Proponents believe NFTs will be used in the future to represent the ownership of a broader range of digital and physical goods and find wider application in other fields, such as identity verification and granting access to events, retail, and online communities. As NFT technology continues to evolve, the core concepts of decentralization, unique digital ownership, and immutability may take different forms or develop into other new technologies.

Web3 and Metaverse

Supporters anticipate that NFTs will become an integral component of Web3 and the metaverse.⁵² Web3 refers to a proposed decentralized architecture for the web built on blockchain technologies, protocols, and applications such as cryptocurrencies.⁵³ In a Web3 architecture, NFTs or cryptocurrencies could potentially be used to purchase items online, represent digital ownership, pay royalties to content creators, and access applications and services. Critics argue that Web3 represents a shift to a “token economy” where the need to exchange cryptocurrencies and NFTs for most interactions and transactions results in the “financialization of everything.”⁵⁴ For example, tokens or cryptocurrencies may be required to access certain Web3 platforms,

ARTnews, January 28, 2022, <https://www.artnews.com/art-news/news/opensea-nft-limit-controversy-1234617074/>.

⁵⁰ Anne Fauvre-Willis, “Authenticity on OpenSea: Updates to Verification and Copymint Prevention,” OpenSea Blog, May 11, 2022, <https://opensea.io/blog/announcements/improving-authenticity-on-opensea-updates-to-verification-and-copymint-prevention/>; Kelly Crow, “Scammers and Hackers See New Frontier in NFT Art,” *Wall Street Journal*, August 27, 2021.

⁵¹ Dipanjan Das et al., “Understanding Security Issues in the NFT Ecosystem,” ACM Conference on Computer and Communications Security, November 7, 2022, <https://arxiv.org/pdf/2111.08893.pdf>.

⁵² Iman Bashir, “The Metaverse, NFTs and the Inevitability of Web3,” *Forbes*, April 15, 2022, <https://www.forbes.com/sites/forbestechcouncil/2022/04/15/the-metaverse-nfts-and-the-inevitability-of-web3/?sh=7122aba228d0>.

⁵³ For more information on Web3, see CRS In Focus IF12075, *Web3: A Proposed Blockchain-Based, Decentralized Web*, by Kristen E. Busch.

⁵⁴ Rex Woodbury, “What Happens When You’re the Investment,” *The Atlantic*, November 29, 2021, <https://www.theatlantic.com/ideas/archive/2021/11/financialization-everything-investment-system-token/620804/>.

creating services that are closed off to users unless they meet certain financial conditions. Web3 is often linked to and discussed alongside the metaverse, a highly immersive and interactive online world made possible through technologies such as virtual reality and augmented reality. Some supporters believe that NFTs may be used in the metaverse for “various branding, trading or identity functions within virtual worlds,”⁵⁵ the purchase of virtual real estate in the metaverse,⁵⁶ or creating “skins” or physical appearances for online characters and avatars.

Because NFTs can, in principle, tokenize and represent unique ownership of anything, some supporters believe that NFTs may be used as a form of digital identity.⁵⁷ In an NFT identity registry, the credential takes the form of an NFT.⁵⁸ NFT-based digital identity systems could exist outside of Web3 or the metaverse, but these concepts are often proposed together and interlinked by supporters. Both Web3 and the metaverse are amorphous concepts, with their own limitations and policy implications. Moreover, depending on how both develop, NFTs may play either an integral or a small role in their architectures.

Campaign Fundraising

NFTs have been used for political and campaign fundraising,⁵⁹ though the practice is infrequent.⁶⁰ Campaigns and candidates in Minnesota, California, Arizona, and Wisconsin have issued tokens to reward donations, attract supporters, build community, and make campaign events exclusive to token-holders.⁶¹ NFT issuances may also be used to signal a candidate’s broader supporter for cryptocurrency, NFTs, and blockchain-related industries. As of May 2022, the Federal Election Commission (FEC) has not issued formal guidance on NFTs, but FEC Commissioner Ellen Weintraub has said that the use of NFTs fits “plainly into existing rules and regulations” as “long as it falls within contribution limits.”⁶² Some states, such as California, have issued guidance on NFTs in campaign fundraising, clarifying that the entire purchase price of an NFT must be reported as a contribution on a campaign committee’s campaign statements.⁶³

⁵⁵ Peter Cramer and Brendan O’Rourke, “As NFTs Blur the Line Between ‘Receipt’ and ‘Product,’ Trademarks Owners Fight over New Virtual Markets,” Proskauer Rose, April 12, 2022, <https://www.blockchainandthelaw.com/2022/04/as-nfts-blur-the-line-between-receipt-and-product-trademarks-owners-fight-over-new-virtual-markets/>.

⁵⁶ Raisa Bruner, “Why Investors Are Paying Real Money for Virtual Land,” *Time*, January 20, 2022, <https://time.com/6140467/metaverse-real-estate/>.

⁵⁷ Zachary Ignoffo, “The New Use Case for NFTs—Solving Online Identity Verification,” Privacy Affairs, June 9, 2022, <https://www.privacyaffairs.com/nft-identity-verification/>.

⁵⁸ See section on “Non-Fungible Token Registry” in Loïc Lesavre et al., *A Taxonomic Approach to Understanding Emerging Blockchain Identity Management Systems*, National Institute of Standards and Technology, January 14, 2020, <https://doi.org/10.6028/NIST.CSWP.01142020>.

⁵⁹ For more information on campaign fundraising, see CRS Report R41542, *The State of Campaign Finance Policy: Recent Developments and Issues for Congress*, by R. Sam Garrett.

⁶⁰ Laura Romero and Soo Rin Kim, “Not Just for Artwork, NFTs Are Being Used by Political Candidates to Raise Money, Attract Young Supporters,” ABC News, January 26, 2022, <https://abcnews.go.com/Politics/artwork-nfts-political-candidates-raise-money-attract-young-story?id=82445596>.

⁶¹ Teresa Mettela, “Political Hopefuls Turn to NFTs to Raise Funds for Midterm Elections,” *Wall Street Journal*, May 14, 2022, <https://www.wsj.com/articles/political-hopefuls-turn-to-nfts-to-raise-funds-for-midterm-elections-11652520603>.

⁶² Romero and Kim, “Not Just for Artwork;” and Mettela, “Political Hopefuls Turn to NFTs to Raise Funds for Midterm Elections.”

⁶³ California Fair Political Practices Commission, Draft Opinion, No. O-22-001, March 17, 2022, <https://fppc.ca.gov/content/dam/fppc/documents/Opinions/9-Leiderman-draft-opinion.pdf>. For analysis of the guidance, see Amber Maltbie, Bill Powers, and Mariel Turner, “Calif. Charts Regulatory Path for NFTs in Campaign Finance,” *Law 360*,

Congressional Issues

The growth of NFTs has raised concerns about consumer protection, privacy, financial, legal, and environmental risks. Congress may consider the size and impact of the NFT market in determining the appropriate role, if any, for the federal government in overseeing NFT marketplaces. If Congress determines there is a role for the federal government in regulating NFTs, it may consider a range of options to provide regulation and oversight while fostering innovation. Since NFTs are used for a variety of purposes, from investing in digital artwork to enabling access to certain online communities, Congress may consider whether to treat NFTs as a broad technology class or target specific NFT applications in certain sectors. Congress may also wish to consider the distinctions among different types of NFTs and their respective purposes.

Consumer Protection

Currently, there are a number of risks to consumers in the NFT ecosystem, and some NFT marketplaces and digital wallets lack basic security features to protect consumers. Scammers have impersonated famous artists to sell NFTs,⁶⁴ created fake marketplace platforms to collect credit card and other financial information,⁶⁵ and engaged in phishing schemes and ransomware attacks. Hackers have exploited vulnerabilities in the code underlying NFT smart contracts to steal NFTs.⁶⁶ Because individuals can transfer NFTs to any digital wallet address, consumers may receive unsolicited spam, pornographic content, or abusive material in the form of NFTs. To remove unwanted NFTs from their wallets, users must pay transaction fees, which may be prohibitive for many users.

One type of large-scale NFT and cryptocurrency scam has become so common that it earned its own name: “rug pull.” In a rug pull, a scammer may create an NFT or cryptocurrency project, solicit and attract other investors, artificially inflate the value of the token by announcing fake project developments to excite the community, and then abruptly abandon the project and fraudulently retain the project investors’ funds, precipitating a massive price drop.⁶⁷ Other investors may lose significant funds and be left with valueless tokens after the price drop.

These kinds of fraud and misleading or deceptive practices in the NFT ecosystem may fall under the jurisdiction of existing federal agencies. In 2022, the Department of Justice and Internal Revenue Service (IRS) charged individuals for NFT fraud and money laundering in a \$1.1 million “rug pull scheme.”⁶⁸ Under Title 15, Section 45, of the *U.S. Code*, the Federal Trade Commission (FTC) has authority over unfair or deceptive acts or practices, including deceptive advertisements. Misleading or false NFT advertisements, terms of service, or IP and copyright agreements—such as those misrepresenting the transfer of ownership of copyright or those with

May 13, 2022, <https://www.law360.com/commercialcontracts/articles/1493182>.

⁶⁴ Das et al., “Understanding Security Issues in the NFT Ecosystem.”

⁶⁵ Crow, “Scammers and Hackers See New Frontier.”

⁶⁶ Russell Brandom, “\$1.7 Million in NFTs Stolen in Apparent Phishing Attack on OpenSea Users,” *The Verge*, February 20, 2022.

⁶⁷ Matt Levine, “Pump and Dump and Pull the Rug,” *Bloomberg Opinion*, July 1, 2021, <https://www.bloomberg.com/opinion/articles/2021-07-01/pump-and-dump-and-pull-the-rug>.

⁶⁸ Department of Justice, U.S. Attorney’s Office, Southern District of New York, “Two Defendants Charged in Non-Fungible Token (‘NFT’) Fraud and Money Laundering Scheme,” press release, March 24, 2022, <https://www.justice.gov/usao-sdny/pr/two-defendants-charged-non-fungible-token-nft-fraud-and-money-laundering-scheme-0>.

deceptive or fluctuating NFT valuations⁶⁹—may fall under the jurisdiction of the FTC. For example, in 2018, the FTC charged multiple individuals for deceptive cryptocurrency money-making schemes that misrepresented referral schemes as bona fide money-making opportunities and falsely claimed that participants could earn income by participating.⁷⁰ Similarly misleading or deceptive NFT money-making schemes may also fall under the FTC’s authorities. However, as of April 2022, the FTC has not taken any enforcement actions specifically involving NFTs.

If NFTs are considered securities, the Securities and Exchange Commission (SEC) may also have enforcement authority over undisclosed payments for NFT promotional activities, as well as disclosure requirements that deter fraud and help investors assess the risk of security offerings. The treatment of NFTs as securities is discussed in the “Financial Regulation” section below.

Other unforeseen consumer protection issues may arise as the NFT market grows. Congress may consider a variety of approaches to address consumer protection issues in NFT markets, such as directing the FTC, SEC, or other relevant federal agencies to take action on consumer protections in NFT markets; increasing funding for enforcement activities against fraudulent or misleading NFT platforms; directing agencies to develop guidance on NFTs for consumers; or requiring increased disclosures.

Copyright and Legal Ownership

The relationship between NFTs and the legal ownership of digital or physical property is unclear. As discussed in the “What Does It Mean to Own an NFT?” section, NFTs do not necessarily confer legal or copyright ownership of the digital or physical items associated with the NFT unless explicitly stated elsewhere in external terms and conditions or contracts.

Under federal law, copyright grants creators a set of exclusive rights to prevent others from, among other things, copying or selling their creative works.⁷¹ The copyright holder generally has the exclusive right to reproduce the work, publicly perform and display it, distribute it, and prepare derivative works from it.⁷² Copyright holders do not need to apply to the government to obtain copyright, because it applies upon creation, although registration confers important legal benefits.⁷³ As of 2022, most NFTs do not explicitly transfer ownership or copyright of an underlying item to the buyer. Some external agreements grant a license for personal, non-commercial use, while others may grant a license that allows commercial use. Some NFTs do not provide any information on how or whether the underlying digital or physical item may be used.

Some NFT marketplaces may have misleading advertisements or terms of service that lead consumers to believe they are purchasing “true ownership” or copyright of digital or physical items associated with the NFTs’ metadata. However, claims of authenticity are often made based on links to an item, even when no legal connection between an item and NFT token is

⁶⁹ Sumeet Chugani and Trevor Levine, “The Notorious NFT: Consumer Protection Issues Raised by Non-Fungible Tokens (NFTs),” Thomson Reuters Practical Law, April 15, 2021, <https://content.next.westlaw.com/practical-law/document/I0d808b9b97b311ebbea4f0dc9fb69570/The-Notorious-NFT-Consumer-Protection-Issues-Raised-by-Non-Fungible-Tokens-NFTs>.

⁷⁰ Federal Trade Commission, “FTC Shuts Down Promoters of Deceptive Cryptocurrency Schemes,” press release, March 16, 2018, <https://www.ftc.gov/news-events/news/press-releases/2018/03/ftc-shuts-down-promoters-deceptive-cryptocurrency-schemes>.

⁷¹ CRS In Focus IF10986, *Intellectual Property Law: A Brief Introduction*, by Kevin J. Hickey.

⁷² For more information on exclusive rights for copyrighted works, see 17 U.S.C. §106.

⁷³ For example, copyright registration is typically a prerequisite for filing federal copyright infringement claims. See 17 U.S.C. §408.

established.⁷⁴ For example, NFTs of public domain works have been minted, but they do not represent ownership, as exclusive intellectual property rights do not apply to the public domain. Additionally, some attorneys have noted that “when a platform reserves the right to shut down a user’s account or deny a user access to their NFTs, that would seem to conflict with the idea that users have any meaningful rights to these assets at all.”⁷⁵

The growth of NFTs marketplaces may be contributing to an increase in copyright infringement for digital art and other online content. In many NFT marketplaces, scammers can easily “tokenize” art they did not create, as proof of legal ownership of the underlying artwork is often not required to mint a token. There are no industry-wide data on the volume or proportion of NFTs that may violate copyright laws. However, some individual company data may provide insight into the potential scale of the problem. In 2022, OpenSea tweeted that it found that 80% of its NFTs “were plagiarized works, fake collections, and spam,” but the company later recanted this figure.⁷⁶ Other companies, such as DeviantArt, offer services for artists to check whether any of their works have been published as NFTs without their permission. In 2021, DeviantArt found 25,000 NFTs that had been sold without the permission of the artists.⁷⁷

There are aspects of copyright law that may impact NFT creators and NFT marketplaces. The Digital Millennium Copyright Act (DMCA) contains “safe harbor” provisions that may impact whether a marketplace could be held liable for a copyright infringement by a third party. Copyright infringement occurs when a person exercises an exclusive right granted by copyright without the copyright holder’s permission.⁷⁸ One provision of the DMCA, codified as Title 17, Section 512, of the *U.S. Code*, shelters online service providers from liability for indirect copyright infringement on their platforms under certain conditions if the provider does not have knowledge of infringement and institutes certain processes to allow copyright owners to notify the provider of alleged infringement. The safe harbor provisions have eligibility requirements, such as applying only if the online service provider “does not receive a financial benefit directly attributable to the infringing activity” and has the “right and ability to control such activity.”⁷⁹

Pursuant to the DMCA, OpenSea maintains a notice-and-takedown process for alleged copyright infringement. According to OpenSea, if the company receives a takedown request that fulfills the requirements of the DMCA, it will delist an NFT (meaning it is removed from the marketplace but remains on the blockchain). However, individual artists may have to manually monitor NFT marketplaces for fraudulent listings of their works and submit individual copyright infringement takedown requests, which may be difficult or time-intensive.

Some Members of Congress have introduced legislation to amend the DMCA.⁸⁰ These bills have included provisions to amend certain exemptions or require the Copyright Office and National

⁷⁴ Moringiello and Odinet, “The Property Law of Tokens.”

⁷⁵ Jessica Rizzo, “The Future of NFTs Lies with the Courts,” *Wired*, April 3, 2022, <https://www.wired.com/story/nfts-cryptocurrency-law-copyright/>.

⁷⁶ Scheck, “OpenSea’s NFT Free-for-All.”

⁷⁷ Scheck, “OpenSea’s NFT Free-for-All.”

⁷⁸ For more information on the DMCA, see CRS In Focus IF11478, *Digital Millennium Copyright Act (DMCA) Safe Harbor Provisions for Online Service Providers: A Legal Overview*, by Kevin J. Hickey.

⁷⁹ 17 U.S.C. §512.

⁸⁰ The SMART Copyright Act of 2022 (S. 3880) and Sen. Thom Tillis’s 2020 discussion draft to reform the DMCA are recent examples of legislation to amend the DMCA and address copyright issues. For more information on Tillis’s discussion draft, see Office of Sen. Thom Tillis, “Tillis Releases Landmark Discussion Draft to Reform the Digital Millennium Copyright Act,” press release, December 22, 2020, <https://www.tillis.senate.gov/2020/12/tillis-releases-landmark-discussion-draft-to-reform-the-digital-millennium-copyright-act>.

Telecommunications and Information Administration to establish best practices for online service providers to be eligible for the liability safe harbors. If passed, such legislation could potentially apply to NFT platforms and other online service providers.

There are other gaps in existing regulations that may impact NFT markets. Under existing laws, content creators who are not paid their due NFT royalties may have little legal recourse to claim these funds. For example, automated resale royalty payments might not occur if an NFT is resold through a different platform than the one where it was minted. According to legal analysts, “US law does not recognize resale rights relating to creative works, so the law provides no recourse for unpaid resale royalties in the US, as it does in approximately 70 other jurisdictions, including the UK and the EU.”⁸¹ Bills were introduced in the 112th and 115th Congresses that “would have enabled artists to earn royalties from subsequent sales when their works are resold.”⁸²

Financial Regulation

Because NFTs are used for a variety of purposes, Congress may want to consider whether to treat NFTs as a broad technology class or address specific NFT applications in certain sectors, such as finance. For example, if NFTs are considered securities, that classification might impact the development of NFT applications in other sectors.

Classification

Depending on how they are used in particular industries, some NFTs may fit under existing regulatory regimes, while others may not. The existing regimes for digital assets, such as cryptocurrencies, differ based on a variety of factors. As of June 2022, there is no agency with overarching authority over digital assets. Various financial regulators may apply existing authorities depending on whether the asset behaves like a bank, a medium of exchange, or a commodity. Furthermore, market actors in the NFT ecosystem may be treated differently under financial regulations depending on the role they play. In a 2022 report, the Department of the Treasury noted:

Depending on the nature and characteristics of the NFTs offered, these platforms may be considered virtual asset service providers (VASP) by FATF [the Financial Action Task Force] and may come under the Financial Crimes Enforcement Network (FinCEN) regulations.... Similarly, platforms or other persons doing business transferring virtual assets during the buying or selling of NFTs may have U.S. AML/CFT [Anti-Money Laundering/Combating the Financing of Terrorism] obligations under FinCEN’s rules for money service businesses if they are doing business in the United States.⁸³

⁸¹ White & Case, “The Rise of NFTs—Opportunities and Legal Issues,” April 23, 2021, <https://www.jdsupra.com/legalnews/the-rise-of-nfts-opportunities-and-9565689/>.

⁸² See the Equity for Visual Artists Act of 2011 (H.R. 3688 and S. 2000, 112th Congress) or the American Royalties Too Act of 2018 (H.R. 6868 and S. 3488, 115th Congress). If introduced today, similar legislation could potentially apply to NFT marketplaces as well as other art markets, in addition to artists’ ability to earn royalties online through NFTs or other methods. In 2012, Congress directed the U.S. Copyright Office to review how the current copyright legal system affects and supports visual artists and how a federal resale royalty right for visual artists would affect current and future practices. The Copyright Office published a report in response stating its support for congressional consideration of a resale royalty right. For more information, see “Resale Royalties: An Updated Analysis,” Office of the Register of Copyrights, December 2013, <https://www.copyright.gov/docs/resaleroyalty/usco-resaleroyalty.pdf>.

⁸³ Department of the Treasury, “Study of the Facilitation of Money Laundering and Terror Finance Through the Trade in Works of Art,” February 2022, https://home.treasury.gov/system/files/136/Treasury_Study_WoA.pdf.

Congress may consider whether to treat certain NFTs as digital assets similar to cryptocurrencies and stablecoins while weighing the possible implications for other NFT applications. For example, if NFTs are considered securities, that classification might impact other uses of NFTs, such as for the metaverse or Web3.

FATF Classifications

FATF is an intergovernmental policymaking body that establishes international standards to combat money laundering and the financing of terrorism.⁸⁴ FATF has no enforcement capability but can suspend member countries (which include the United States) that fail to comply on a timely basis with its guidelines. In 2021, FATF released updated guidance to evaluate NFTs for potential regulation as virtual assets (VAs).⁸⁵ The guidance states, “Some NFTs that on their face do not appear to constitute VAs may fall under the VA definition if they are to be used for payment or investment purposes in practice.”⁸⁶ It also recommends that countries consider the application of the FATF standards to NFTs on a case-by-case basis.

FinCEN Classifications

FinCEN is a Department of the Treasury bureau with the mission “to safeguard the financial system from illicit use, combat money laundering and its related crimes including terrorism, and promote national security through the strategic use of financial authorities and the collection, analysis, and dissemination of financial intelligence.”⁸⁷ In 2011, FinCEN issued a final rule that defined *money transmission services* to include accepting and transmitting currency, funds, or “other value that substitutes for currency ... by any means.”⁸⁸

Some NFTs may fall under these existing FinCEN money transmission definitions. If FinCEN determines that NFTs are “value that substitutes for currency” or that NFT platforms engage in “money transmission” through NFTs, certain NFT companies could be required to register as money service businesses and be subject to the Bank Secrecy Act (P.L. 91-508), which requires the establishment and maintenance of AML programs, among other compliance requirements.⁸⁹

FinCEN has retroactively considered other blockchain and cryptocurrency-related products to be VASPs. For example, in 2019, FinCEN began treating stablecoin issuers as VASPs. In past

⁸⁴ CRS Report RS21904, *The Financial Action Task Force: An Overview*, by James K. Jackson.

⁸⁵ The report defines a VA as “a digital representation of value that can be digitally traded, or transferred, and can be used for payment or investment purposes. Virtual assets do not include digital representations of fiat currencies, securities and other financial assets that are already covered elsewhere in the FATF Recommendations.” See FATF, *Updated Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers*, 2021, <https://www.fatf-gafi.org/media/fatf/documents/recommendations/Updated-Guidance-VA-VASP.pdf>.

⁸⁶ According to the Department of Justice, a non-convertible virtual currency may effectively become a convertible virtual currency when a secondary market for the currency develops and provides the opportunity to exchange the “non-convertible” currency for fiat or other virtual currency. See U.S. Department of Justice, “Cryptocurrency: Enforcement Framework,” October 2020, <https://www.justice.gov/archives/ag/page/file/1326061/download>; and FATF, “Virtual Currencies Key Definitions and Potential AML/CFT Risks,” June 2014, <https://www.fatf-gafi.org/media/fatf/documents/reports/Virtual-currency-key-definitions-and-potential-aml-cft-risks.pdf>.

⁸⁷ U.S. Department of the Treasury, Financial Crimes Enforcement Network, “Mission,” <https://www.fincen.gov/about/mission>.

⁸⁸ 31 C.F.R. § 1010.100.

⁸⁹ For more information on money service businesses and money transmitters, see CRS Report R46486, *Telegraphs, Steamships, and Virtual Currency: An Analysis of Money Transmitter Regulation*, by Andrew P. Scott. For more information on AML, FinCEN, and cryptocurrencies, see CRS Report R45664, *Virtual Currencies and Money Laundering: Legal Background, Enforcement Actions, and Legislative Proposals*, by Jay B. Sykes and Nicole Vanatko.

decisions, FinCEN also considered some initial coin offering (ICO) issuers and decentralized applications to be money transmission services.⁹⁰ In a 2022 report, the U.S. Treasury Department noted that FinCEN could use recordkeeping and reporting requirements to obligate certain art market participants, including NFT platforms and market participants, to create and maintain AML/CFT programs.⁹¹

SEC Classifications⁹²

NFTs may be considered securities in certain circumstances under the jurisdiction of the SEC.⁹³ One factor that may influence the securities status of NFTs is that they can be fractionalized (i.e., investors can purchase a subdivided portion of an NFT or a fraction of a large NFT collection). These fractionalized NFTs are typically fungible tokens, representing part ownership of a larger non-fungible token, and can be traded in secondary markets. Additionally, if an NFT generates income streams such as royalty payments or dividends, it may have potential to be deemed a security.

If NFTs are securities, the SEC may have regulatory and enforcement authority against NFT marketplaces and platforms.⁹⁴ Additionally, the issuer of an NFT would then be required to disclose certain facts about the product.⁹⁵ The SEC enforces securities disclosure requirements and has previously charged celebrities for failing to disclose payments they received for promoting initial coin offerings (ICOs).⁹⁶ ICOs are a funding mechanism in which projects sell their tokens in exchange for cryptocurrencies or fiat currency.⁹⁷

Illicit Activity

In a 2022 report, the Treasury Department identified money laundering vulnerabilities in the structure of NFT marketplaces. The report noted that “the incentive to transact can potentially be higher than the incentive to verify the identity of the buyer of the work, or even can create a situation where it is not possible to conduct due diligence if transactions are conducted in rapid succession.”⁹⁸ For example, OpenSea earns 2.5% of every transaction on its marketplace, which

⁹⁰ FinCEN, “Application of FinCEN’s Regulations to Certain Business Models Involving Convertible Virtual Currencies,” May 9, 2019, <https://www.fincen.gov/sites/default/files/2019-05/FinCEN%20CVC%20Guidance%20FINAL.pdf>.

⁹¹ Department of the Treasury, “Study of the Facilitation of Money Laundering and Terror Finance Through the Trade in Works of Art.”

⁹² For more information on SEC regulation of NFTs, see CRS Report R46208, *Digital Assets and SEC Regulation*, by Eva Su.

⁹³ CRS Report R46208, *Digital Assets and SEC Regulation*, by Eva Su.

⁹⁴ The courts and SEC use the “Howey” and “Reves” tests to determine whether a financial instrument may qualify as a security. In 2019, the SEC released a framework on the application of Howey to digital assets. See SEC, “Framework for ‘Investment Contract’ Analysis of Digital Assets,” <https://www.sec.gov/corpfin/framework-investment-contract-analysis-digital-assets>.

⁹⁵ CRS In Focus IF11256, *SEC Securities Disclosure: Background and Policy Issues*, by Eva Su.

⁹⁶ In 2018, the SEC charged rapper DJ Khaled and boxer Floyd Mayweather for failing to disclose promotional payments from ICO issuers. Both individuals promoted the coins on social media but did not disclose their payments from the issuers. SEC, “Two Celebrities Charged with Unlawfully Touting Coin Offerings,” press release, November 29, 2018, <https://www.sec.gov/news/press-release/2018-268>.

⁹⁷ For more information on ICOs, see CRS Report R46208, *Digital Assets and SEC Regulation*, by Eva Su.

⁹⁸ Department of the Treasury, “Study of the Facilitation of Money Laundering and Terror Finance Through the Trade in Works of Art.”

may incentivize the company to prioritize transaction volume over money laundering and illicit activity concerns. NFTs may be particularly susceptible to money laundering since they are easily sent across geographic borders without incurring the financial or regulatory costs of physical shipping. Additionally, the price of digital art is highly variable, which enables money launderers to set the desired value with little historical context in which to compare prices.⁹⁹

The Treasury Department's report recommended information-sharing programs for art dealers, law enforcement training, and potential rulemaking that would subject certain art dealers to AML and know-your-customer requirements, all of which could impact NFT marketplaces.¹⁰⁰

International groups have also recognized the possible money laundering risks and threats posed by NFTs. In 2022, the Joint Chiefs of Global Tax Enforcement (known as "J5") released an intelligence bulletin on risks associated with NFTs and NFT marketplaces. The J5 was formed in 2018 to combat transnational tax crime. Its members represent the United States, Canada, Australia, the United Kingdom, and the Netherlands.¹⁰¹

As NFT marketplaces have grown in popularity, so have their illicit trading practices. In the aforementioned 2022 report, the Treasury Department noted that NFTs are susceptible to "wash trades," in which assets are traded back and forth by the same account to drive up their valuation.¹⁰² The structure of NFT marketplaces may incentivize these illicit activities.¹⁰³ Wash trading is illegal under Title 7, Section 1, of the *U.S. Code* and the Commodity Exchange Act of 1936. The Commodity Futures Trade Commission (CFTC), SEC, and IRS also have authorities over wash trading.¹⁰⁴ The CFTC previously settled charges against cryptocurrency exchange Coinbase for wash trading.¹⁰⁵ As of April 2022, no agency has taken enforcement action on NFT wash trading. Other illicit practices, such as shill bidding and bid shielding, have also become issues in NFT marketplaces.¹⁰⁶ Congress may wish to consider directing agencies to take

⁹⁹ Matthew Long, "The New Digital Art Trade Is Ideal for Criminals," Bloomberg Law, April 20, 2021, <https://news.bloomberglaw.com/white-collar-and-criminal-law/the-new-digital-art-trade-is-ideal-for-criminals>.

¹⁰⁰ Department of the Treasury, "Study of the Facilitation of Money Laundering and Terror Finance Through the Trade in Works of Art."

¹⁰¹ The J5 includes the Australian Taxation Office, the Canada Revenue Agency, the Dutch Fiscal Information and Investigation Service, Her Majesty's Revenue and Customs from the U.K., and the Internal Revenue Service Criminal Investigation Division from the United States. See IRS, "J5 NFT Marketplace Red Flag Indicators," <https://www.irs.gov/pub/irs-utl/j5-media-release-4-28-2022.pdf>.

¹⁰² Department of the Treasury, "Study of the Facilitation of Money Laundering and Terror Finance Through the Trade in Works of Art."

¹⁰³ For example, to verify a collection (a family of NFTs with similar traits or a common theme), OpenSea requires sellers to have at least 100 ETH (Ethereum's native cryptocurrency) in trading volume. This may present challenges for new artists or collections and thereby incentivize users to engage in wash trading. One industry data aggregator found more than \$8 billion worth of wash trading on the NFT marketplace LooksRare, which at the time had amassed only around \$9.5 billion worth of trades in total. See CryptoSlam, "Wash Trading: Who, What, Why, and What Should We Do About It?," January 28, 2022, <https://blog.cryptoslam.io/wash-trading-who-what-why-and-what-should-we-do-about-it/>; Andrew Hayward, "LooksRare Has Reportedly Generated \$8B in Ethereum NFT Wash Trading," January 28, 2022, <https://decrypt.co/91510/looksrare-has-reportedly-generated-8b-ethereum-nft-wash-trading>.

¹⁰⁴ The CFTC prohibits abusive trading practices, such as wash trading, under the Commodity Exchange Act and CFTC regulations, including 17 C.F.R. §1. The SEC has also charged individuals for engaging in wash trading under the Securities Exchange Act of 1934 and the Securities Act of 1933. The IRS has a wash-sale rule, under 26 U.S.C. §1091, that prevents writing off an investment loss from wash trading.

¹⁰⁵ CFTC, "CFTC Orders Coinbase Inc. to Pay \$6.5 Million for False, Misleading, or Inaccurate Reporting and Wash Trading," press release, March 19, 2021, <https://www.cftc.gov/PressRoom/PressReleases/8369-21>.

¹⁰⁶ Shill bidding is when a seller artificially inflates the price by bidding on his or her own asset or colluding with other bidders. In bid shielding, a bidder guards the lowest bid by bidding high enough to deter legitimate bidders from placing additional bids.

enforcement action on NFTs or issue new rules through the rulemaking process to address NFT-related AML issues.

Energy and Environmental Impacts

Both minting and selling NFTs require substantial amounts of energy, which has raised concerns about their environmental impact.¹⁰⁷ As with cryptocurrencies,¹⁰⁸ many NFTs are created and traded on Proof of Work (PoW) blockchain networks. PoW is one of the most common consensus mechanisms, which is how the network reaches a consensus and agrees on transactions that are added to the blockchain. In PoW networks, the “computers” on the blockchain network compute millions of difficult calculations to verify transactions,¹⁰⁹ requiring substantial amounts of energy to run these calculations.¹¹⁰ The PoW consensus mechanism was specifically designed to be resource-intensive to prevent bad actors from obtaining the computational power to attack and take control of the network. Thus, scholars and industry representatives refer to the energy intensity as a “feature, not a bug” of the system.¹¹¹

CRS could not determine the exact energy consumption or environmental impact of NFTs. It is likely that NFT transactions consume similar amounts of energy as cryptocurrency transactions. The creation of an NFT, its sale or trade, and all subsequent sales and trades are recorded as transactions on blockchains. Since many NFTs are created and traded on PoW networks, each transaction validation consumes energy.¹¹² Some NFT blockchains, such as Cardano and Solana, use less-energy-intensive consensus mechanisms to validate transactions, such as Proof of Stake, Proof of Authority, or Proof of History.¹¹³

Some Members of Congress have expressed concern about the energy and environmental impacts of cryptocurrencies and NFTs. In January 2022, the House Energy and Commerce Committee held a hearing on cryptocurrency energy consumption.¹¹⁴ Later that month, eight Members sent a

¹⁰⁷ Gregory Barber, “NFTs Are Hot. So Is Their Effect on the Earth’s Climate,” *Wired*, March 6, 2021; Justine Calma, “The Climate Controversy Swirling Around NFTs,” *The Verge*, March 15, 2021.

¹⁰⁸ For more information on cryptocurrency energy consumption, see CRS Report R45863, *Bitcoin, Blockchain, and the Energy Sector*, by Corrie E. Clark and Heather L. Greenley.

¹⁰⁹ For more information on the energy consumption of PoW, see CRS Report R45863, *Bitcoin, Blockchain, and the Energy Sector*, by Corrie E. Clark and Heather L. Greenley. PoW validation is typically done by application-specific integrated circuits (ASICs) specifically designed to conduct PoW calculations and validate blockchain transactions. These ASICs can be used only for PoW calculations and may also contribute to increasing e-waste.

¹¹⁰ For PoW blockchains, miners compete in a “hashing race” to find a nonce (an arbitrary random number) that will produce a certain hash value once put through a hashing function. A hashing function produces a string of characters as an output given some data as input. This is a one-way function, meaning a hash value may be created from an input, but the input cannot be recreated from the hash. The miners increment through nonce values until one of them finds a hash value that meets the target criteria, which may change depending on the difficulty level. For more information on hashing and nonces, see Dylan Yaga et al., *Blockchain Technology Overview*, National Institute of Standards and Technology, October 2018, <https://nvlpubs.nist.gov/nistpubs/ir/2018/NIST.IR.8202.pdf>.

¹¹¹ During a hearing on cryptocurrency energy consumption, John Belizaire, the CEO of Soluna Computing, testified, “The point I want you to remember from my testimony today is that crypto’s energy consumption is a feature, not a bug.” See U.S. Congress, House Committee on Energy and Commerce, Subcommittee on Oversight and Investigations, “Cleaning Up Cryptocurrency: The Energy Impacts of Blockchains,” 117th Cong., January 20, 2022.

¹¹² MoneySuperMarket, “Crypto Energy Consumption,” <https://www.moneysupermarket.com/gas-and-electricity/features/crypto-energy-consumption/>.

¹¹³ CRS Report R45863, *Bitcoin, Blockchain, and the Energy Sector*, by Corrie E. Clark and Heather L. Greenley.

¹¹⁴ House Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce, hearing on “Cleaning Up Cryptocurrency: The Energy Impacts of Blockchains,” January 20, 2022.

letter to cryptomining companies requesting more information on their energy consumption and environmental impacts.¹¹⁵ Another group of Members sent a letter to the Environmental Protection Agency to ensure that cryptomining facilities are not violating environmental statutes.¹¹⁶ In March 2022, President Biden issued Executive Order 14067, “Ensuring Responsible Development of Digital Assets,” which requires several federal agencies to collaborate and produce a report on the connections between blockchain technologies and a variety of energy and environmental issues.¹¹⁷ Depending on how NFTs are used and classified (e.g., as digital assets, art pieces, digital identity tokens), efforts aimed at addressing the energy consumption of digital assets may or may not extend to NFTs.

Privacy and Content Moderation

There are also privacy and content moderation concerns associated with NFTs and NFT marketplaces. By design, NFT data and transactions are publicly viewable and permanently recorded on blockchains. If a user’s public key address is linked to a real-world identity, all of the user’s transactions can be publicly tracked on the blockchain.¹¹⁸ The features of immutability and pseudonymity may conflict with users’ desire to maintain privacy or delete certain public information after transactions. To take an NFT out of circulation, a user must pay a transaction fee to send the NFT to a “burn address,” which is a wallet that can only receive and not transfer tokens.¹¹⁹ In this way, the NFTs can be removed from being sold on marketplaces, even though they cannot be deleted from a blockchain. Additionally, if sensitive data are stored on blockchains through NFTs, users may be unable to correct these records if there are errors or falsifications. On the other hand, some international groups have used NFTs and the immutability of blockchains to avoid government censorship of online information.¹²⁰

Most NFT marketplaces claim to take down NFTs that abuse or violate their terms and conditions. For example, OpenSea has removed white supremacist and racist NFTs and content creators from their marketplace, even though the content remains on the blockchain. OpenSea previously stated it takes enforcement action against 3,500 NFT collections every week. As of January 2022, the company said this represented 0.175% of its total collections.¹²¹

If NFTs become an integral part of future Web3 or metaverse online ecosystems and architectures, content moderation and privacy issues may become more prevalent and

¹¹⁵ Letter from Sen. Elizabeth Warren et al., January 27, 2022, <https://www.warren.senate.gov/imo/media/doc/2022.01.27%20Letters%20to%20Cryptominers.pdf>.

¹¹⁶ Letter from Rep. Jared Huffman et al. to Michael S. Regan, Administrator of the Environmental Protection Agency, April 20, 2022, <https://huffman.house.gov/imo/media/doc/Crypto%20letter%20to%20EPA%20FINAL.pdf>.

¹¹⁷ Executive Order 14067, “Executive Order on Ensuring Responsible Development of Digital Assets,” March 9, 2022, <https://www.whitehouse.gov/briefing-room/presidential-actions/2022/03/09/executive-order-on-ensuring-responsible-development-of-digital-assets/>.

¹¹⁸ Eric Ravenscraft, “NFTs Are a Privacy and Security Nightmare,” *Wired*, April 5, 2022, <https://www.wired.com/story/nfts-privacy-security-nightmare/>.

¹¹⁹ Mintable, “How Do I Delete or Burn My NFTs?,” <https://docs.mintable.app/ethereum-version/faq/how-do-i-delete-or-burn-my-nfts>.

¹²⁰ Ben Schreckinger, “NFTs vs. China,” *Politico*, May 23, 2022, <https://www.politico.com/newsletters/digital-future-daily/2022/05/23/nfts-vs-the-ccp-00034487>; Shen Lu and Karen Hao, “NFTs Are Put to New Use in China, Countering Censorship During Pandemic,” *Wall Street Journal*, May 21, 2022, <https://www.wsj.com/articles/nfts-are-put-to-new-use-in-china-countering-censorship-during-pandemic-11653134403>.

¹²¹ Lois Beckett, “‘Huge Mess of Theft and Fraud’: Artists Sound Alarm as NFT Crime Proliferates,” *The Guardian*, January 29, 2022, <https://www.theguardian.com/global/2022/jan/29/huge-mess-of-theft-artists-sound-alarm-theft-nfts-proliferates>.

consequential. Congress may want to consider whether existing privacy laws adequately address NFTs and other information that is permanently recorded in blockchain networks. In the context of online content moderation, government regulation of NFTs may also implicate the First Amendment's Free Speech Clause.¹²² A consideration for Congress may be whether certain NFT content and privacy concerns are sufficiently detrimental to public well-being to warrant legislative action.

Concluding Observations

As of 2022, most NFTs are used for digital collectibles and artwork. They may expand in the future to a wider array of applications and uses or become obsolete with the development of other alternative decentralized technologies. Even if NFTs in their current form become obsolete, the core concepts of decentralization, unique digital ownership, and immutability are likely to continue in the emergence of new technologies. While NFTs or new decentralized applications may prove beneficial, they also raise concerns about consumer protection, privacy, financial, legal, and environmental risks. Congress faces the issues of (1) support for the further technical development and innovation of NFTs and (2) consideration of measures to mitigate accompanying risks.

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¹²² CRS Legal Sidebar LSB10742, *Online Content Moderation and Government Coercion*, by Valerie C. Brannon and Whitney K. Novak; CRS Report R46662, *Social Media: Misinformation and Content Moderation Issues for Congress*, by Jason A. Gallo and Clare Y. Cho.